Project Publications (and publications in press):

1. Lederberg, J., Sutherland, G.L., Buchanan, B.G., Feigenbaum, E.A., Robertson, A.V., Duffield, A.M., and Djerassi, C., "Applications for Artificial Intelligence for Chemical Inference I. The Number of Possible Organic Compounds: Acyclic Structures Containing C,H,O and N". Journal of the American Chemical Society May 1969.

2. Duffield, A.M., Robertson, A.V., Djerassi, C., Buchanan, B.G., Sutherland, G.L., Feigenbaum, E.A., and Lederberg, J., "Applications of Artificial Intelligence for Chemical Inference II. Interpretation of Low Resolution Mass Spectra of Ketones". Journal of the American Chemical Society May 1969.

3. Schroll, G., Duffield, A.M., Djerassi, C., Buchanan, B.G., Sutherland, G.L., Feigenbaum, E.A., and Lederberg, J., "Applications of Artificial Intelligence for Chemical Inference III. Aliphatic Ethers Diagnosed by Their Low Resolution Mass Spectra and NMR Data". Submitted to the Journal of the American Chemical Society.

4. Sutherland, G.L., Heuristic DENDRAL: "A Family of LISP Programs". To appear in D. Bobrow (ed.), LISP Applications. Also, Stanford Artificial Intelligence Project Memo AI-80.

5. Churchman, C.W. and Buchanan, B.G., "On the Design of Inductive Systems: Some Philosophical Problems". British Journal for the Philosophy of Science, to appear Autumn 1969 (in press).

6. Lederberg, J., "Topology of Molecules". In The Mathematical Sciences, published for the National Academy of Sciences--National Research Council by MIT Press, Cambridge, 1969, pp. 37-51.

7. Buchanan, B.G., Sutherland, G.L., and Feigenbaum, E.A., "Heuristic DENDRAL: A Program for Generating Explanatory Hypotheses in Organic Chemistry". In D. Michie (ed), Machine Intelligence 4 University of Edinburgh Press, 1969. (Also, Stanford Artificial Intelligence Project Memo AI-62.)

8. Feigenbaum, E.A., "Artificial Intelligence: Themes in the Sound Decade". In Final Supplement to Proceedings of the IFIP68 International Congress, Edinburgh, August 1968. (Also Artificial Intelligence Project Memo AI-67.)

9. Lederberg, J., and Feigenbaum, E.A., "Mechanization of Inductive Inference in Organic Chemistry". In B. Kleinmuntz (ed) Formal Representations for Human Judgment, Wiley, 1968. (Also Stanford Artificial Intelligence Project Memo AI-54.)

10. Lederberg, J., "Hamilton Circuits of Convex Trivalent Polyhedra". American Mathematical Monthly 74, 522 (1967).

11. Lederberg, J., "Topological Mapping of Organic Molecules", Proceedings of the National Academy of Science, U.S. 53, 134 (1965).

REPORTS

A. Lederberg J. DENDRAL 64 - A system for computer construction, enumeration and notation of organic molecules as tree structures and cyclic graphs.

A.1. Part I, Notational algorithm for tree structures, NASA CR-57029 and STAR N65-13158.

A.2. Part II, Topology of cyclic graphs, NASA CR-68898 and STAR N66-14074.

A.3. Part III, A general outline of the DENDRAL system. Systematics of organic molecules, graph topology and Hamilton circuits, NASA CR-68899 and STAR N66-14075.

B. Sutherland, G.L., "A Computer Program for Generating and Filtering Chemical Structures. Stanford Artificial Intelligence Project Memo AI-49.

6.2 Language Research

There are a number of problems relating to the automatic processing of natural language which are continuing to be of interest. This is divided into three major sub-areas: associative data structures, models of cognitive structures and grammatical inference.

We have been studying the problems of associative memory in conventional computers for several years. The most recent development is the abiility to have several independent, parallel programs all sharing the same associative structure. We hope to study the problems of controlling access to a global structure in the context of hand-eye tasks. Another important tope to be studied is the addition of deductive inference cap bilities to the associative retrieval mechanisms.

One of the most interesting and difficult problems in artificial intelligence is the modeling of human cognitive structures. We have developed such a model [2] and are studying several problems in language processing and understanding with this model. The model is unique in that it uses the notion of consequence (temporal, causal, etc.) as a central element. We are developing theories of analogy, generalization over instances and the relation between perception and understanding using this model.

Work on grammatical inference continues to be fruitful. The theoretical work on decidability is complete [3] and we are looking at questions of optimal learning and teaching strategies. Many of these results will be directly converted into program heuristics. We are also studying the extension of these techniques to other problems of generalization.

REFERENCES

1. Feldman, J., and Rovner, P., "An Algol-Based Associative Language", Stanford Artificial Intelligence Memo AI-66, Stanford University, Stanford, California, August 1968.

2. Feldman, J.A., "First Thoughts on Grammatical Inference", Stanford Artificial Intelligence Memo AI-55, Stanford University, Stanford, California, August 1967.

3. Feldman, J.A., Gips, J., Horning, J., and Reder, S., "Grammatical Inference and Complexity", Stanford Artificial Intelligence Memo AI-89, Stanford University, Stanford, California, June 1969.

4. Becker, J.D., "The Modeling of Simple Analogic and Inductive Processes In a Semantic Memory System", Stanford Artificial Intelligence Memo AI-77, Stanford University, Stanford, California, January 1969.

6.3 Higher Mental Functions

The Higher Mental Functions Project is an affiliated project under the direction of Dr. Kenneth Mark Colby, who is supported by N.I.H, as a Research Career Scientist. This project is working on two problem areas: (1) The Study of credibility functions in humans as well as in aritificial systems, (2) Question-asking or interviewing programs which operate in natural language.

In the first area of interest the problem is to understand how a system, living or artificial, judges the credibility of new information based on information it already possesses. Descriptions of work already done on this problem can be found in Reference (1, 2, 3). Because the relevant variables are difficult to control in humans, it is considered necessary to develop artificial belief systems in which the belief processes under study can be brought under maximum control.

In the second domain of interest, the problem consists of machine understanding of natural language. We have have considerable experience in this area (See Reference 4) and we are currently developing a program which conceptually analyzes natural language input. (See Reference 5). Once the input is "understood" the program can generate questions based on information it has received thus far rather than being limited to a fixed set of questions.

REFERENCES

1. Colby, K.M., "Computer Simulation of Change in Personal Belief Systems", Behavorial Science, 12, 248-253 (1967).

2. Tesler, L., Colby, K.M., and Enea, H., "A Directed Graph for Computer Simulation of Belief Systems", Mathematical Biosciences, 2, 19-40 (1968).

3. Colby, K.M., Tesler, L., Enea, H., "Search Experiments with the Data Base of Human Belief Structure", Proc. International Joint Conference on Artificial Intelligence, Washington, D.C., May 1969.

4. Colby, K.M., and Enea, H., "Heuristic Methods for Computer Understanding of Natural Language in Context-Restricted On-Line Dialogues", Mathematical Biosciences, 1, 1-25, 1967.

7. Budget

$1,975,859 is needed to support the research program described above for the eighteen month period beginning 1 January 1969. The budget below is divided into an initial six month period ($613,527 from 1 January through 30 June 1970) and following twelve month period ($1,362,332 from 1 July 1970 through 30 June 1971). Separate budgets are given for the Heuristic Dentral Project (H.D.) and the other artificial intelligence projects (A.I.) in each period. The Higher Mental Functions Project is separately supported so no funds are needed for it.

The bulk of the funds requested are for salaries and personnel support costs. $20,000 per year is needed for test equipment, mostly in support of the visual perception and control projects. $80,000 is budgeted in the second period for additional displays consoles. The existing 6 console display system is currently in saturated use about 18 hours per day and the utilization is increasing.

BUDGET SUMMARY

For Continuation of SD 183

1 Jan 1970 - 30 Jun 1971

Budget Item	1 Jan 1970 - 30 Jun 1970		1 Jul 1970 - 30 Jun 1971		Total
	A.I.	H.D.	A.I.	H.D.	
Salaries	$240,483	$31,588	$509,825	$66,967	$848,863
Staff Benefits	29,579	3,885	62,708	8,237	104,409
University Overhead	137,075	18,005	290,600	38,171	483,851
Travel	8,900	2,250	17,800	4,500	33,450
Capital Equipment	10,000		100,000		110,000
Equipment Rental	28,176	2,520	56,352	5,040	92,088
Equipment Maintenance	25,000		50,000		75,000
Computer Time	2,000	36,000	4,000	72,000	114,000
Communications	7,500	1,000	15,000	2,000	25,500
Publications Costs	4,125	441	8,250	882	13,698
Other Operating Expenses	22,250	2,750	44,500	5,500	75,000
Subtotal by Project	$515,088	$98,439	$1,159,035	$203,297	$1,975,859
Total by Period	$613,527		$1,362,332		$1,975,859

BUDGET FOR CONTINUATION (1 Jan 70 - 30 Jun 71)

SD 183

I. ARTIFICIAL INTELLIGENCE	1 Jan 70 - 30 Jun 70	1 Jul 70 - 30 Jun 71
Faculty		
Adams, J.L., Assoc. Prof. of Mech. Engr., 1/6 time acad, yr., 1/2 time summer	$2,216	$4,698
Feldman, J., Assoc. Prof. of Computer Science, 1/2 time acad. yr., full time summer	5,391	11,429
Floyd, R., Assoc. Prof. of Computer Science, 1/2 time acad. yr., full time summer	7,291	15,457
Knuth, D., Prof. of Computer Science	—	
Manna, Z., Assist. Prof. of Computer Science, 1/2 time acad. yr., full time summer	4,628	9,811
McCarthy, J., Prof. of Computer Science, Principal Investigator, 1/2 time acad. yr., full time summer	8,333	17,666
Reddy, D.R., Assist. Prof. of Computer Science, 1/2 time acad. yr., full time summer	5,168	10,956
TOTAL FACULTY SALARIES	$33,027	$70,017
Research Staff		
Ashcroft, E.A. Research Assoc.	$ 6,600	$13,992
Baumgart, B., Systems Programmer	4,800	10,176
Beauchamp, J. Research Assoc.	6,300	13,356

Research Staff cont'd.

	1 Jan 70 - 30 Jun 70	1 Jul 70 - 30 Jun 71
Earnest, L., Research Assoc., Executive Officer	$11,500	$24,380
Feldman, G., Research Programmer 1/2 time acad. yr., full time summer	3,694	7,831
Gleason, G., Computer Systems Engineer	6,630	14,056
Grape, G., Research Programmer	5,400	11,448
Hueckel, M., Research Assoc.	6,600	13,992
Kay, A., Research Assoc. 3/4 time	6,000	12,720
Luckham, D. Research Assoc.	8,010	16,981
McGuire,E., Systems Programmer	4,800	10,176
Moorer, J., Systems Programmer	5,160	10,939
Paul, R., Research Programmer	6,780	14,374
Pingle, K., Research Programmer	5,940	12,593
Poole, D., Systems Programmer	5,550	11,766
Samuel, A., Senior Research Assoc., 3/4 time	10,000	21,200
Singer, J., Systems Programmer, Group Leader	7,650	16,218
Smith, D., Systems Programmer 1/5 time	1,080	2,290
Sproul, R., Systems Programmer	4,800	10,176
Weiher, W., Systems Programmer	5,400	11,448
TOTAL RESEARCH STAFF	$122,694	$260,112

			1 Jan 70 - 30 Jun 70	1 Jul 70 - 30 Jun 71
	Student Research Assistants (20)			
	J. Allen, R. Bajcsyova, J. Becker, J. Buchanan, L. Erman, G. Falk, R. Goodman, M. Kelly, R. Neely, P. Petit, L. Quam, J. Ryder, R. Schmidt, I. Sobel, D. Swinehart, J. Tenebaum, plus 4 unnamed:			
	TOTAL STUDENT RESEARCH ASSISTANTS		$47,000	$99,640
	Other Staff			
	Baur, Q., Secretary, 1/2 time		1,500	3,180
	Down, K., Research Coordinator, 9/10 time		5,400	11,448
	Panofsky, E., Electronics Technician		3,900	8,268
	Roark, D., Secretary		3,000	6,360
	Zingheim, T., Electronics Technician		4,350	9,222
	-----, Electronics Technician		3,600	7,632
	Semi-monthly Technicians		2,400	5,088
	TOTAL OTHER STAFF		$24,150	$51,198
	SUBTOTAL A.I. PROJECT SALARIES		$226,871	$480,967
	Allowance for 6% Salary Increase		13,612	28,858
	TOTAL A.I. PROJECT SALARIES		$240,483	$509,825
II.	Staff Benefits (12.3% Provisional through 31 August 1970)		$29,579	$62,708
III.	University Overhead (57%)		$137,075	$290,600
IV.	Travel			
	2 foreign trips, $1,200 ea.	$2,400		
	9 trips east, $450 ea.	4,050		
	2 professional staff moves to Stanford, $750 ea.	1,500		
	Local travel	950		
			$8,900	

			1 Jan 70 - 30 Jun 70	1 Jul 70 - 30 Jun 71
IV.	Travel (continued)			
	5 foreign trips, $1,200 ea.	$6,000		
	16 trips east, $450 ea.	7,200		
	4 professional staff moves to Stanford, $750 ea.	3,000		
	Local travel	1,600		
				$17,800
V.	Capital Equipment			
	Test Equipment (Oscilloscopes, arm and camera instrumentation, misc.)		$10,000	$20,000
	Display generator and 6 display units (Similar to Data Disc Units)			80,000
	TOTAL CAPITAL EQUIPMENT		$10,000	$100,000
VI.	Equipment Rental			
	IBM Disc File and Packs		$28,176	$56,352
VII.	Equipment Maintenance (Based on past experience)		$25,000	$50,000
VIII.	Computer Time (IBM 360-67)			
	3 hours day rate, $500/hr	$1,500		
	Supporting Services	500		
			$2,000	
	6 hours day rate, $500/hr	$3,000		
	Supporting Services	1,000		
				$4,000
IX.	Communications (Telephones, data-phones, teletype)		$7,500	$15,000
X.	Publications Costs		$4,125	$8,250
XI.	Other Operating Expenses		$22,250	$44,500
	TOTAL ARTIFICIAL INTELLIGENCE		$515,088	$1,159,035

		1 Jan 70 - 30 Jun 70	1 Jul 70 - 30 Jun 71
XII.	HEURISTIC DENDRAL		
	Faculty		
	Feigenbaum, E., Prof. of Computer Science, 65 % time acad. yr., full time summer	$8,500	$18,020
	Lederberg, J., Prof. of Genetics, 5 % time	1,000	2,120
	TOTAL FACULTY SALARIES	$9,500	$20,140
	Research Staff		
	Buchanan, B., Research Associate	$6,800	$14,416
	Delfino, A., Research Programmer	6,000	12,720
	Sutherland, G., Research Associate 2/3 time	3,750	7,950
	Brown, D., Student Research Asst., 1/2 time acad. yr., full time summer	1,500	3,180
	Semimonthly wages (undergraduate student)	750	1,590
	TOTAL RESEARCH STAFF	$18,800	$39,856
	Other Staff		
	-----, Secretary, 1/2 time	$1,500	$3,180
	SUBTOTAL HEURISTIC DENDRAL SALARIES	$29,800	$63,176
	Allowance for 6% Salary Increase	$1,788	$3,791
	TOTAL HEURISTIC DENDRAL SALARIES	$31,588	$66,967
XIII.	Staff Benefits (12.3% Provisional through 31 August 1970)	$3,885	$8,237
XIV.	University Overhead (57%)	$18,005	$38,171

			1 Jan 70 - 30 Jun 70	1 Jul 70 - 30 Jun 71
XV.	Travel			
	1 foreign trip, $1,200 ea.	$1,200		
	2 trips east, $450 ea.	900		
	Local travel	150		
			$2,250	
	2 foreign trips, $1,200 ea.	$2,400		
	4 trips east, $450 ea.	1,800		
	Local travel	300		
				$4,500
XVI.	Equipment Rental (Wylbur Terminals)		$2,520	$5,040
XVII.	Computer Time (IBM 360-67)			
	60 hours day rate, $500/hr	$30,000		
	Supporting Services	6,000		
			$36,000	
	120 hours day rate, $500/hr	$60,000		
	Supporting Services	12,000		
				$72,000
XVIII.	Communications (Telephones, data-phones, teletype)		$1,000	$2,000
XIX.	Publications Costs		$441	$882
XX.	Other Operating Expenses		$2,750	$5,500
	TOTAL HEURISTIC DENDRAL		$98,439	$203,297

XXI. Associated Groups - Non-Direct Support

A. Higher Mental Functions

Colby, K., Principal Investigator, Senior Research Associate

Hilf, F., Research Associate

Schank, R., Programmer

Tesler, L., Programmer

Smith, D., Research Programmer, 4/5 time

A. Higher Mental Functions (Continued)

Weber, S., Student Research Assistant, 1/2 time acad. yr., full time summer

Down, K., Research Coordinator, 1/10 time

Baur, Q., Secretary, 1/2 time

8. Cognizant Personnel:

For contractual matters, including overhead and patent questions:

Elwood C. Pierce
Office of the Research Administrator
Stanford University
Stanford, California 94305

For technical and scientific matters:

Professor John McCarthy, Principal Investigator
Professor Edward Feigenbaum, Associate Investigator
Dr. Arthur Samuel, Associate Investigator
Mr. Lester Earnest, Executive Officer
Computer Science Department
Stanford University
Stanford, California 94305

Telephone (415) 321-2300, extension 4971

For administrative matters, including questions relating to the budget, property acquisition and handling, etc:

Mr. Lester Earnest, Executive Officer
Mr. Kenneth Down, Research Coordinator
Computer Science Department
Stanford University
Stanford, California 94305

Telephone (415) 321-2300, extension 4971

APPENDIX A

PUBLICATIONS OF PROJECT MEMBERS

Articles and books by members of the Stanford Artificial Intelligence Project are listed here by year. Only publications subsequent to the individual's affiliation with the Project are given.

1963

1. J. McCarthy, "A Basis for a Mathematical Theory of Computation", in P. Biaffort and D. Hershberg (eds), Computer Programming and Formal Systems, North-Holland, Amsterdam 1963.

2. J. McCarthy, "Towards a Mathematical Theory of Computation" in Proc. IFIP Congress 62, North-Holland, Amsterdam, 1963.

3. J. McCarthy (with S. Boilen, E. Fredkin, and J.C.R. Licklider), "A Time-Sharing Debugging System for a Small Computer" in Proc. AFIPS Conf. (SJCC), Vol. 23, 1963.

4. J. McCarthy (with F. Corbato and M. Daggett), "The Linking Segment Subprogram Language and Linking Loader Programming Languages", Comm. ACM, July 1963.

1965

1. J. McCarthy, "Problems in the Theory of Computation", in Proc. IFIP Congress 65, Spartan, Washington, D.C., 1965.

1966

1. A. Hearn, "Computation of Algebraic Properties of Elementary Particle Reactions Using a Digital Computer", Comm. ACM, 9, pp. 573-577, August 1966.

2. J. McCarthy, "A Formal Description of a Subset of Algol" in T. Steele (ed), Formal Language Description Languages, North-Holland, Amsterdam, 1966.

3. J. McCarthy, "Information", Scientific American, September 1966.

4. D. Reddy, "Segmentation of Speech Sounds", J. Acoust. Soc. Amer., August 1966.

1967

1. S. Brodsky and J. Sullivan, "W-Boson Contribution to the Anomalous Magnetic Moment of the Muon", Phys Rev 156, 1644, 1967.

2. J. Campbell, "Algebraic Computation of Radiative Corrections for Electron-Proton Scattering", Nuclear Physics, Vol. B1, pp. 238-300, 1967.

3. E. Feigenbaum, "Information Processing and Memory" in Proc. Fifth Berkeley Symposium on Mathematical Statistics and Probability, Vol. 4, U.C. Press, Berkeley, 1967.

4. J. Goodman, "Digital Image Formation from Electronically Detected Holograms", in Proc. SPIE Seminar on Digital Imaging Techniques, Soc. Photo-Optical Instrumentation Engineering, Redondo Beach, California, 1967.

5. J. Goodman, "Digital Image Formation from Electronically Detected Holograms", Applied Physics Letters, 1 August 1967.

6. A. Hearn, "REDUCE, A User-Oriented Interactive System for Algebraic Simplification, Proc. ACM Symposium on Interactive Systems for Experimental Applied Mathematics, August 1967.

7. J. Lederberg, "Hamilton Circuits of Convex Trivalent Polyhedra", American Mathematical Monthly 74, 522, 1967.

8. J. McCarthy, D. Brian, G. Feldman, and J. Allen, "THOR - A Display Based Time Sharing System", AFIPS Conf. Proc., Vol. 30, (FJCC), Thompson, Washington, D.C., 1967.

9. J. McCarthy, "Computer Control of a Hand and Eye", in Proc. Third All-Union Conference on Automatic Control (Technical Cybernetics), Nauka, Moscow, 1967 (Russian).

10. D. Reddy, "Phoneme Grouping for Speech Recognition", J. Acoust. Soc. Amer., May 1967.

11. D. Reddy, "Pitch Period Determination of Speech Sounds", Comm. ACM, June 1967.

12. D. Reddy, Computer Recognition of Connected Speech", J. Acoust. Soc. Amer., August 1967.

13. A. Samuel, "Studies in Machine Learning Using the Game of Checkers, II-Recent Progress", IBM Journal, November 1967.

14. G. Sutherland (with G.W. Evans and G.F. Wallace), Simulation Using Digital Computers, Prentice-Hall, Engelwood Cliffs, N.J., 1967.

1968

1. E. Feigenbaum, J. Lederberg and B. Buchanan, "Heuristic Dendral", Proc. International Conference on System Sciences, University of Hawaii and IEEE, University of Hawaii Press, 1968.

2. E. Feigenbaum, "Artificial Intelligence: Themes in the Second Decade", Proc. IFIP Congress 1968.

3. J. Feldman (with D. Gries), "Translator Writing Systems", Comm. ACM, February 1968.

4. J. Feldman (with P. Rovner), "The Leap Language Data Structure", Proc. IFIP Congress 1968.

5. R. Gruen and W. Weiher, "Rapid Program Generation", Proc. DECUS Symposium, Fall 1968.

6. A. Hearn, "The Problem of Substitution", Proc. IBM Summer Institute on Symbolic Mathematics by Computer, July 1968.

7. D. Kaplan, "Some Completeness Results in the Mathematical Theory of Computation", ACM Journal, January 1968.

8. J. Lederberg and E. Feigenbaum, "Mechanization of Inductive Inference in Organic Chemistry", in B. Kleinmuntz (ed.), Formal Representation of Human Judgment, John Wiley, New York, 1968.

9. J. McCarthy, "Programs with Common Sense" in M. Minsky (ed.), Semantic Information Processing, MIT Press, Cambridge, 1968.

10. J. McCarthy, L. Earnest, D. Reddy, and P. Vicens, "A Computer with Hands, Eyes, and Ears", Proc. AFIPS Conf. (FJCC), 1968.

11. K. Pingle, J. Singer, and W. Wichman, "Computer Control of a Mechanical Arm through Visual Input", Proc. IFIP Congress 68, 1968.

12. D. Reddy, and Ann Robinson, "Phoneme-to-Grapheme Translation of English", IEEE Trans. Audio and Electroacoustics, June 1968.

13. D. Reddy, "Computer Transcription of Phonemic Symbols", J. Acoust. Soc. Amer., August 1968

14. D. Reddy, and P. Vicens, "Procedure for Segmentation of Connected Speech", J. Audio Eng. Soc., October 1968.

15. D. Reddy, "Consonantal Clustering and Connected Speech Recognition", Proc. Sixth International Congress on Acoustics, Vol. 2, pp. C-57 to C-60, Tokyo, 1968.

1968 (cont.)

16. A. Silvestri and J. Goodman, "Digital Reconstruction of Holographic Images", '68, NEREM Record, IEEE, Vol. 10, pp. 118-119, 1968.

17. L. Tesler, H. Enea, and K. Colby, "A Directed Graph Representation for Computer Simulation of Belief Systems", Math. Bio. 2, 1968.

1969 (to date)

1. J. Beauchamp (with H. Von Foerster) (eds), Music by Computers, John Wiley, New York, 1969.

2. J. Becker, "The Modeling of Simple Analogic and Inductive Processes in a Semantic Memory System," Proc. International Conf. on Artificial Intelligence, Washington, D.C., 1969.

3. B. Buchanan and G. Sutherland, "Heuristic Dendral: A Program for Generating Hypotheses in Organic Chemistry", in D. Michie (ed.), Machine Intelligence 4, American Elsevier, New York, 1969.

4. B. Buchanan (with C. Churchman), "On the Design of Inductive Systems: Some Philosophical Problems", British Journal for the Philosophy of Science, Autumn 1969 (in press).

5. K. Colby, L. Tesler, and H. Enea, "Experiments with a Search Algorithm for the Data Base of a Human Belief System", Proc. International Conference on Artificial Intelligence, Washington, D.C., 1969.

6. K. Colby and D.C. Smith, "Dialogues between Humans and Artificial Belief Systems", Proc. International Conference on Artificial Intelligence, Washington, D.C., 1969.

7. A. Duffield, A. Robertson, C. Djerassi, B. Buchanan, G. Sutherland, E. Feigenbaum, and J. Lederberg, "Application of Artificial Intelligence for Chemical Inference II. Interpretation of Low Resolution Mass Spectra of Ketones", J. of American Chemical Society, May 1969.

8. J. Feldman, G. Feldman, G. Falk, G. Grape, J. Pearlman, I. Sobel, and J. Tenenbaum, "The Stanford Hand-Eye Project", Proc.International Conf. on Artificial Intelligence, Washington, D.C., 1969.

9. J. Feldman (with P. Rovner), "An Algol-based Associative Language", Comm. ACM, August 1969.

10. T. Ito, "Note on a Class of Statistical Recognition Functions", IEEE Trans. Computers, January 1969.

11. J. Lederberg, "Topology of Organic Molecules", National Academy of Science, The Mathematical Sciences: a Collection of Essays, MIT Press, Cambridge 1969.

12. J. Lederberg, G. Sutherland, B. Buchanan, E. Feigenbaum, A. Robertson, A. Duffield, and C. Djerassi, "Applications of Artificial Intelligence for Chemical Inference I. The Number of Possible Organic Compounds: Acyclic Structures Containing C,H,O, and N", J. Amer. Chem. Soc., May 1969.

1969 (cont.)

13. D. Luckham, "Refinement Theorems in Resolution Theory", Proc. 1968 IRIA Symposium in Automatic Deduction, Versailles, France, (in press).

14. Zohar Manna, "Properties of Programs and the First Order Predicate Calculus", J. ACM, April 1969.

15. Zohar Manna, "Formalization of Properties of Programs", J. System and Computer Sciences, May 1969.

16. Zohar Manna and Amir Pnueli, "Formalization of Properties of Recursively Defined Functions", Proc. ACM Symposium on Computing Theory, May 1969.

17. J. McCarthy and P. Hayes, "Some Philosophical Problems from the Standpoint of Artificial Intelligence", in D. Michie (ed), Machine Intelligence 4, American Elsevier, New York, 1969.

18. N. Nilsson, "A Mobile Automaton: An Application of Artificial Intelligence Techniques", Proc. International Conf. on Artificial Intelligence, Washington, D.C., 1969.

19. R. Paul, G. Falk, J. Feldman, "The Computer Representation of Simply Described Scenes", Proc. Illinois Graphics Conference, April 1969.

20. R. Schank and L. Tesler, "A Conceptual Parser for Natural Language", Proc. International Joint Conference On Artificial Intelligence, Washington, D.C., 1969.

21. G. Schroll, A. Duffield, C. Djerassi, B. Buchanan, G. Sutherland, E. Feigenbaum, and J. Lederberg, "Applications of Artificial Intelligence for Chemical Inference III. Aliphatic Ethers Diagnosed by Their Low Resolution Mass Spectra and NMR Data", J. American Chemical Society (in press).

APPENDIX B

THESES

Theses that have been published as Stanford Artificial Intelligence Memos are listed below. Several earned degrees at institutions other than Stanford. Abstracts of all A.I. Memos are given in Appendix D.

Memo

AI-43 R. Reddy, "An Approach to Computer Speech Recognition by Direct Analysis of the Speech Wave", Ph.D. Thesis in Computer Science, Stanford University, September 1966.

AI-46 S. Persson, "Some Sequence Extrapolating Programs: A Study of Representation and Modeling in Inquiring Systems," Ph.D. Thesis in Computer Science, University of California, Berkeley, September 1966.

AI-47 B. Buchanan, "Logics of Scientific Discovery", Ph.D. Thesis in Philosophy, University of California, Berkeley, December 1966.

AI-44 J. Painter, "Semantic Correctness of a Compiler for an Algol-like Language," Ph.D. Thesis in Computer Science, Stanford University, March 1967.

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